

## COLLEMBOLA FROM URBAN AREAS (WARSA V, POLAND)

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The urban area of Warsaw is situated in the Mazowian Lowland, occurs mainly in the potential zone of linden-oak-hornbeam associations (Matuszkiewicz, 1966). Well known are the facts of replacing natural plant associations by anthropogenic ones as a result of long lasting man's activity what corresponds with profound modifications in zoocenoses. For the linden-oak-hornbeam association of *Tilio-Carpinetum* vicariously plant association is *Arrhenatheretum medioeuropaeum* in the case of managementsites as regularly hay-growing and fertilized meadow; on grazed linden-oak hornbeam sites developed pasture association as *Lolio-Cynosuretum*; on ploughland, on linden-oak-hornbeam sites respectively occur arable-field associations (Szafter and Zarzycki 1972).

Up to now, we have weekly investigated environmental modifications in a linden-oak-hornbeam sites caused by urbanization. During the studies on the fauna of Warsaw green spaces evaluated degradation changes caused by anthropogenic pressure in species composition and structure of Collembolans' communities, comparing in the homological series of vicarious linden-oak-hornbeam plant associations.

The material presented here was collected between 1976-1984 year from 25 localities in 4 basic habitats types (forests, meadows, arable fields and orchards, urban greenery). A total of 2305 samples and more than 23 thousand specimens belonging to 96 Collembola species have been taken.

The samples were taken from all sites in A<sub>1</sub> humus accumulation horizon to 10 cm in depth, from a total area of 200 cm<sup>2</sup> each month (from April to October), and than extracted in Tullgren funnels.

The Collembola communities from urban green spaces in comparison with the communities of other linden-oak-hornbeam plant associations characterize distinct differences in their species composition. The urban pressure

and associated with them changes in the environment create favourable conditions for the distribution of many of springtail species at the cities. Habitat and zoogeographical barriers are being transgressed. Species which have not been reported so far from outside green spaces of Warsaw there appear: Cryptopygus ponticus, Cyphoderus bidenticulatus, Xenyllodes ghiljarovi; the typically synanthropic species as Folsomia candida and Seira domestica, are also connected with the city. Some species, in comparison with the other investigated habitats, clearly increase their numbers and frequent of occurrence in urban green spaces: Cryptopygus bipunctatus, Isotoma notabilis, I. viridis, Isotomurus palustris, Sminthurinus aureus and others. On the other hand, species usually dominant in communities of natural linden-oak-hornbeam forests or meadows (Folsomia quadrioculata, Isotomiella minor) practically disappear from the species composition of Collembola in urban green spaces (Fig. 1).

Sminthurinus aureus, Willemia intermedia, Stenaphorura quadrispina, Deuterosminthurus repandus, Bourletiella hortensis, and Folsomia fimetaria have been hierarchically classified as the indicatory species for the Collembola

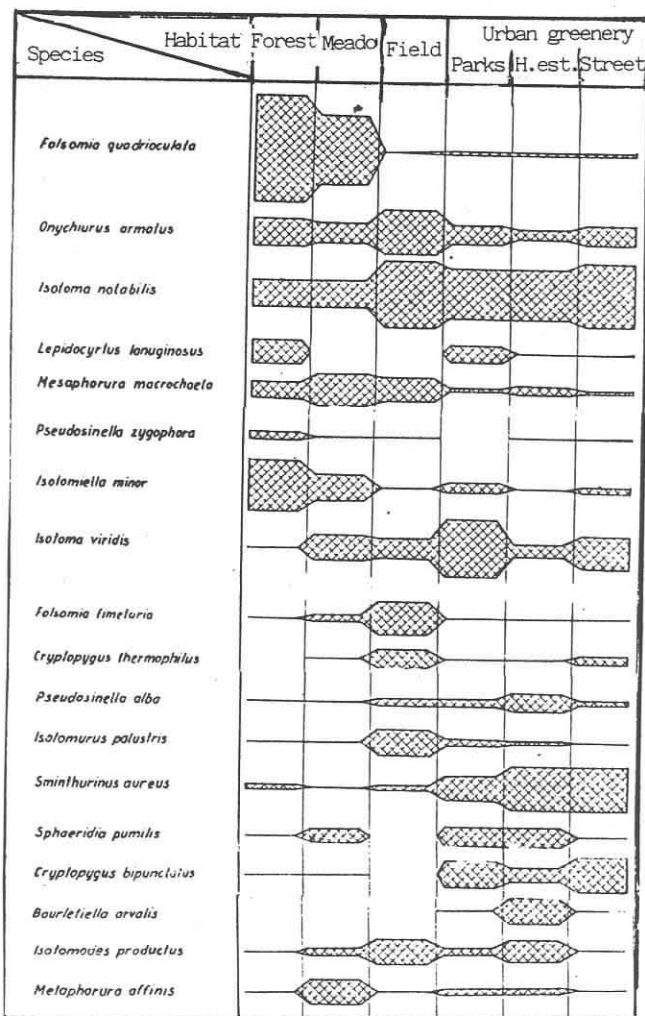


Fig. 1. The impact of anthropogenic pressure on the presence of dominant species of Collembola in the studied environments of the linden-oak-hornbeam forest site in the Mazovian Lowland

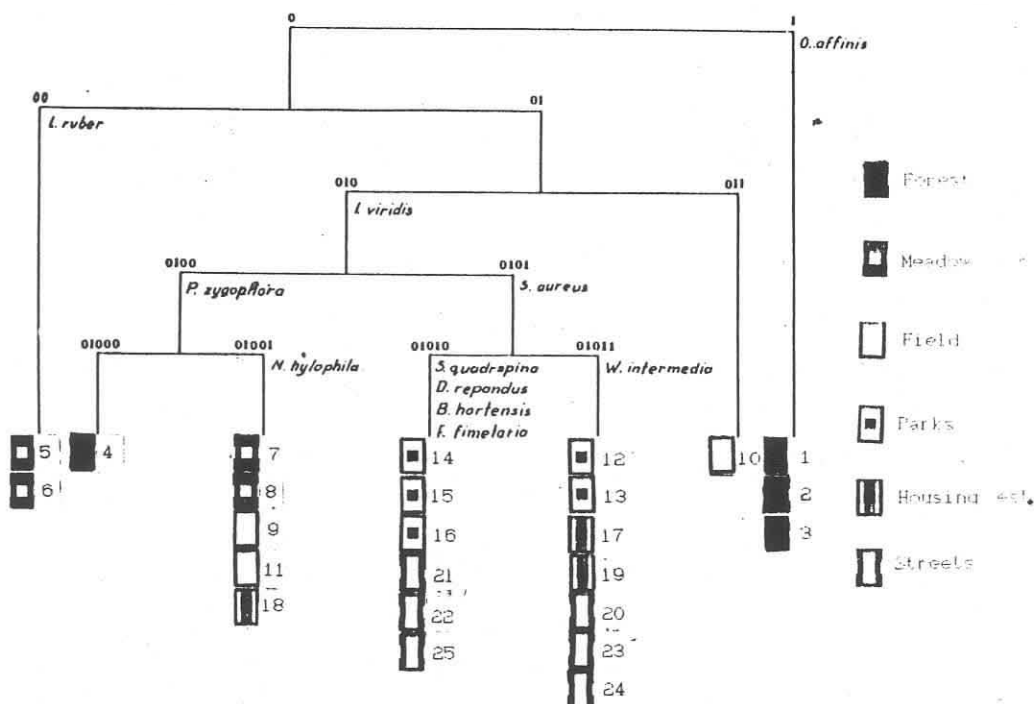


Fig. 2. Twinspan classification of the collembola communities from the studied environments of Mazovian Lowland

communities of the green spaces of Warsaw, while their counterparts in forest soils are *Onychiurus affinis*, and the hygrophilous meadow species, *Lepidocyrtus ruber* in fertile associations of Arrhenatheretum medioeuropaeum type. The communities of strongly-anthropogenic environments, i.e. urban green spaces, arable fields, orchards or degraded linden-oak-hornbeam forests are characterized by the presence of *Isotoma viridis*. A small soil species, *Mesaphorura hylophila*, has been chosen as characteristic for communities from arable fields within a studied Tilio-Carpinetum site (Fig. 2).

Two types of anthropogenic pressure influencing Collembola communities, the agricultural and the urban ones, were considered in the studied site. The agricultural pressure reduces the number of species in springtail communities, while the impact of the urbanization clearly raises the species richness (forests - 61, meadow - 61 species, arable field and orchard - 38, urban green spaces - 75). This relatively large number of species recorded in urban green spaces results from the great diversity of soil

environments there, with their simultaneous similarities to those in natural forests and seminatural meadows. This type of reduction of soil zoocenoses is associated by Weigmann (1987) with biotope structure. If a perturbation increases the diversity of biotope structure (i.e. increases the spatial heterogeneity of an environment), as it happens in green space, there appears an increase in the number of species, while an opposite effects is observed in uniform biotop structure (field monocultures, orchards).

The urban communities of Collembola have a modified ecological species structure in layer and humidity preferences as well as in ecological value in comparison with the communities of forest and meadows. From urban and also from field communities disappear forest and litter species and increases share of compost and, in the urban ones, of myrmecophilous species (Fig. 3). The species connected with the herb layer are practically eliminated

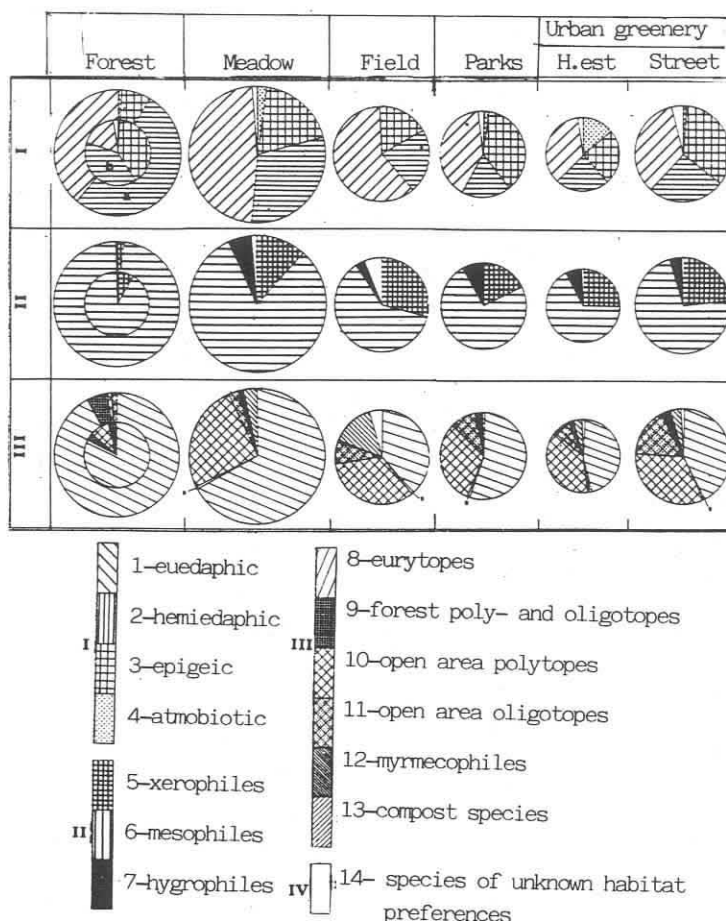


Fig. 3. Species's ecological structure of Collembola communities in the studied environments of the Mazovian Lowland; I-proportion of elements associated with different layers; II-moisture; III-ecological amplitudes and habitats. IV-species of unknown habitat preferences. a-natural forest; b-degraded forest

with their dominance index above 10% and the differences in percentage between the two first dominants are slight. The shares of recedent and subrecedent species groups in comparison with those in communities from natural and seminatural environments are small with the exception of park communities. Generally, urban communities of Collembola are characterized by a considerable disappearance of differences in percentage shares of the particular species. Consequently of the changes in the dominations' structure are respective differences in values of species diversity indexes. It is also characteristic that the values of of the species diversity index and evenness are higher than those in natural environments (Fig. 4).

The spring-tail communities of Warsaw green spaces are clearly similar to those found in open areas (especially pasturelands and arable fields) than in the forest ones (Fig. 5, 6). The observed affinities of the urban Colembola communities to the fauna of meadows, pastures and arable field is connected with the fact that the most species in the urban communities have immigrated there from (once) existing sur-

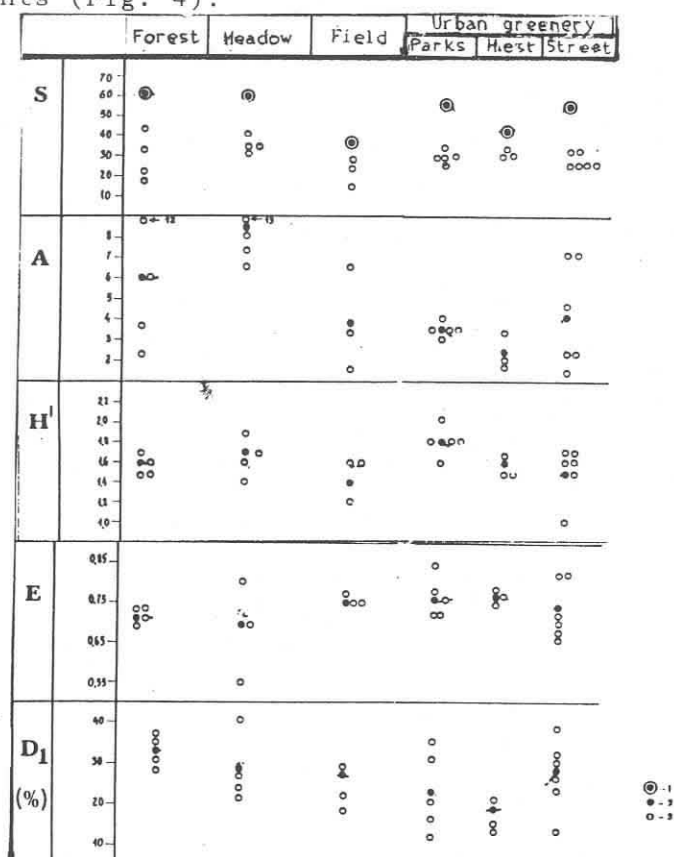


Fig. 4. The values of selected biocenological indicators in the studied Collembola communities of the Mazovian Lowland; S - number of species; A - mean monthly density in thousands of individuals per m<sup>2</sup>; H' - Shannon-Weaver diversity index; E - Pielou evenness index; D - species domination index; 1 - total number of species, 2 - average mean values of analysed indexes, 3 - values of indexes on the individual plots.

from field communities, while they are constantly present in the urban ones (this phenomenon is connected with the frequent moving of the lawns) and, probably, with a vertical migration of those species). The overall numbers and the number of typically euedaphic species decrease in the trampled and poorly aerated soils of urban greens; it is excessive aridity eliminates hygrophiles species from Collembola communities and xerophilous species are favoured, mostly those connected with open habitats.

The urban and the agricultural anthropogenic pressure cause a decrease in the numbers in springtail communities. These numbers are however very differentiated, e.g. diverging from 1.37 to 7.64 thousand individuals per  $m^2$ . This is probably caused by micro-habitats factors, the category of the urban green spaces being of lesser importance here.

The domination structure of Collembola communities functioning in urban green spaces is also very diverse. In polluted soils of streetside lawns and young park's lawn planted on post-agricultural terrain, the prevalence of the dominant species is usually distinct and the species with the dominance index above 10% are very few (1-2) species; on the other hand, old park communities have a high number of species

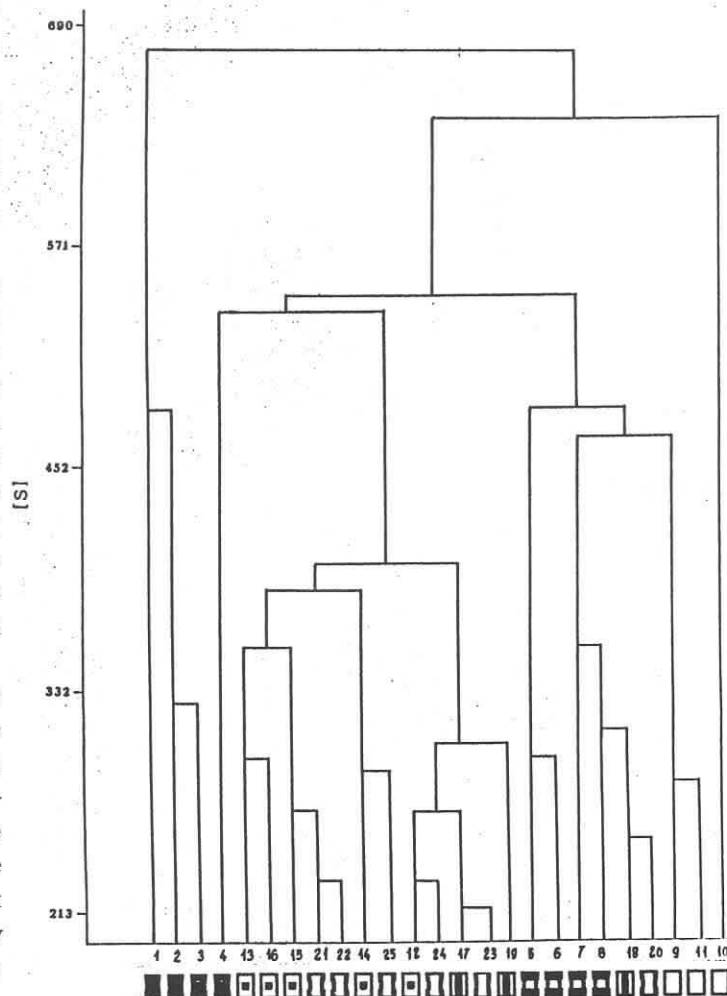


Fig. 5. Faunistic similarity (S) of Collembola communities in the studied sites in the Mazovian Lowland using farthest-neighbor clustering methods of classifying

rounding meadow and field environments; the differences to the field or meadow communities result from the long-term anthropogenic pressure and, probably to small extent, from the persistence of the local species

The great diversity of Collembola communities within studied urban green spaces is connected with the considerable spatial differentiation of such terrains in Warsaw. They differ in degree of eutrophication, allcalization, contamination (e.g. with heavy metals), fertilization, mixing of the soil profile, soil compaction, sod compactness and thickness, etc.; of some importance is also the history of the site (it's age, type of soil, the character of the previous plant association). Undoubtedly, the reaction of

the particular populations and whole communities of Collembola to the same factor of anthropopressure are very different, depending on the conditions of the soil environment exposed to it (Fratello et al., 1986). The generally the high differentiation of the urban environment in terms of biotic and abiotic factors, the presence of the numerous ecotone environments, and the great diversity of stress factors are the causes of such a great diversity of it's communities of Collembola.

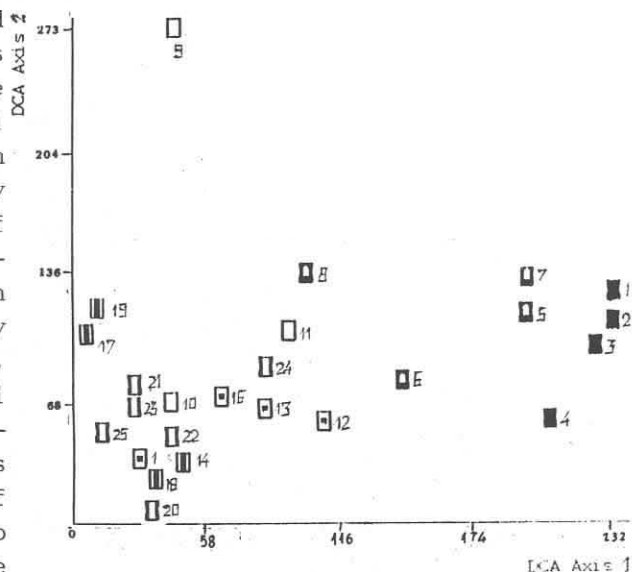


Fig. 6. DCA ordinations of 25 Collembola communities of the linden-oak-hornbeam forest site of the Mazovian Lowland in studied anthropogenic pressure gradient.

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